ZOÖLOGY TEXTBOOKS FOR SECONDARY SCHOOLS

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Even a cursory examination of the texts in zoölogy that have appeared in the last decade or so for use in the secondary schools will show that they are of very varied types. A more careful analysis of the content of books confirms the early impressions. Such books, for instance, as Davenport's *Introduction to Zoölogy*, Kellogg's *The Animals and Man*, Jordan and Kellogg's *Animal Life*, Galloway's *Elementary Zoölogy*, and Hegner's *Practical Zoölogy* are very dissimilar. One is impressed, too, with the fact that a great many of the recent texts have distinctive leanings toward the economic phase of zoölogy, at least in their titles. The Hegner text already referred to, Davison's *Practical Zoölogy*, Daugherty's *Principles of Economic Zoölogy*, and Kellogg and Doane's *Economic Zoölogy* are samples of such texts.

It is a generally accepted law, I believe, in the evolution of animals, as revealed by the fossils, that when a new type appears, marking a new era, it breaks up rapidly into a multitude of somewhat widely divergent subtypes. Possibly one may surmise that the several diverse sorts of zoölogy texts now appearing are indication of a transition from one period in the history of zoölogy instruction to another. A new type of text is in the making. In order to trace the changes in zoölogical instruction, it seemed worth while to undertake, with several classes in the Teaching of Zoölogy, an analysis of a number of secondary zoölogy texts, extending over a considerable period of time.

These students, mostly graduate, had had experience in teaching zoölogy in high schools. They worked under direction and careful instruction, so as to attain, so far as possible, uniformity in results. The accompanying tabulation shows the results of this series of analyses. The author has checked up the results so that

	Agassiz and Gould's *Principles of Zoölogy*	Hooker's *Natural History*	Tenney's *Natural History*	Orton's *Comparative Zoölogy*	Holder's *Elements of Zoölogy*	Nicholson's *Textbook of Zoölogy*	Packard's *First Lessons in Zoölogy*	Colton's *Practical Zoölogy*	Steel's *Popular Zoölogy*	Needham's *Elementary Lessons in Zoölogy*	Boyer's *Elementary Zoölogy*	Parker and Haswell's *Manual of Zoölogy*	Davenport's *Introduction to Zoölogy*	Jordan and Kellogg's *Animal Life*
No. indicating text	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Date	1848	1860	1866	1876	1884	1885	1886	1886	1887	1895	1898	1900	1900	1900
Collecting and preserving	.....	.....	.....	.....	.....	.....	0.3	1.6	.....	1.7	2.1	.....	.....	.....
History of zoölogy	.....	.....	.....	0.4	.....	.....	0.3	.....	.....	.....	.....	.....	.....	.....
Biography	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Bibliography	.....	.....	.....	0.7	1.1	.....	0.6	1.1	.....	0.7	3.4	.....	3.5	.....
Comparative physiology	35.4	2.3	1.2	0.5	3.5	.....	8.3	1.1	1.2	7.4	0.4	4.6	3.3	30.2
Sex	.....	.....	0.4	.....	.....	.....	1.6	.....	.....	.....	.....	.....	.....	3.9
Embryology	11.2	.....	3.2	4.3	1.4	0.9	2.5	1.4	1.3	4.0	0.9	3.5	3.3	3.5
Life-history	5.4	17.4	4.7	2.4	3.8	3.5	35.4	8.2	5.8	7.1	.....	2.2	5.2	8.7
Habits	.....	10.1	45.3	3.4	19.3	4.6	10.6	.....	6.7	12.9	.....	9.6	35.5	20.9
Economic zoölogy	.....	3.5	0.8	.....	1.1	.....	1.0	.....	.....	.....	.....	.....	5.0	.....
Histology	2.2	.....	.....	4.0	.....	.....	1.6	.....	0.2	0.5	0.4	0.7	.....	.....
Geographical distribution	12.4	6.8	5.1	3.0	6.5	10.2	2.0	.....	4.2	.....	.....	.....	2.5	11.2
Classification	3.6	4.8	8.2	4.4	6.8	2.7	6.2	.....	10.9	1.7	1.8	4.0	12.5	2.6
External morphology	.....	41.5	24.7	36.0	43.5	45.8	23.0	36.3	59.1	26.6	19.1	24.8	22.8	4.8
Internal morphology	13.7	5.3	5.4	40.4	10.6	28.2	6.0	47.0	10.8	30.7	23.5	48.2	1.5	2.9
Paleozoölogy	11.6	.....	.....	.....	1.1	0.6	0.1	.....	.....	.....	.....	.....	0.5	.....
Archaeology and ethnology	.....	.....	.....	.....	1.4	0.4	0.1	.....	.....	.....	.....	.....	.....	.....
Evolution	.....	.....	.....	.....	.....	0.9	0.1	.....	.....	0.7	.....	2.4	.....	11.6
Miscellanous zoölogy	5.0	8.0	.....	.....	.....	2.3	.....	3.3	.....	6.0	.....	.....	4.2	.....
Human physiology	.....	.....	0.5	.....	.....	.....	0.2	.....	.....	.....	48.5	.....	.....	.....
Plants	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Physical geography and mineralogy	.....	.....	0.5	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
	100.5	99.7	100.0	99.5	100.1	100.1	99.9	100.0	100.2	100.0	100.1	100.0	99.8	100.3

	Kellogg's *Elementary Zoölogy*	Jordan, Kellogg, and Heath's *Animal Studies*	Linville and Kelly's *Textbook of Zoölogy*	Davidson's *Practical Zoölogy*	Herrick's *A Textbook in Zoölogy*	Bailey and Coleman's *First Course in Biology*	Gallaway's *Elementary Zoölogy*	Hegner's *Introduction to Zoölogy*	Davenport's *Elementary Zoölogy*	Kellogg's *The Animals and Man*	Hunter's *Biology*	Bigelow's *Applied Biology*	Daugherty's *Principles of Economic Zoölogy*	Hegner's *Practical Zoölogy*	Kellogg and Doane's *Economic Zoölogy*
No. indicating text	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
Date	1901	1903	1906	1906	1907	1908	1910	1910	1911	1911	1911	1911	1912	1915	1915
Collecting and preserving	.....	.....	.....	2.3	.....	0.5	.....	.....	.....	3.3	.....	.....	.....	.....	.....
History of zoölogy	.....	.....	3.5	.....	1.8	.....	.....	2.1	2.6	.....	.....	.....	.....	0.8	.....
Biography	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1.2	.....
Bibliography	0.7	.....	.....	0.8	.....	.....	0.5	4.5	2.4	0.6	0.9	0.5	.....	1.0	.....
Comparative physiology	3.0	9.6	12.3	4.5	14.2	.....	15.6	15.0	1.3	13.4	2.7	6.4	5.0	7.5	4.9
Sex	.....	.....	.....	.....	0.7	.....	.....	.....	1.6	.....	0.8	1.8	.....	.....	.....
Embryology	1.5	0.6	4.4	2.8	.....	0.3	4.9	6.9	3.1	1.2	0.9	1.8	1.7	1.2	0.6
Life-history	8.6	5.5	7.0	12.5	6.6	1.5	1.5	13.5	23.0	8.1	1.9	2.7	6.0	1.4	4.5
Habits	11.3	6.0	19.6	16.3	18.6	1.5	17.0	10.5	5.5	12.4	8.3	0.6	30.7	26.3	17.1
Economic zoölogy	4.0	10.4	5.5	20.9	4.0	1.7	4.6	.....	6.6	8.9	9.8	3.9	7.7	33.1	43.9
Histology	0.6	.....	.....	.....	.....	.....	2.0	7.0	0.2	0.9	0.2	1.3	0.5	1.8	.....
Geographical distribution	3.5	2.8	4.2	.....	6.2	0.5	3.0	.....	3.1	1.8	0.8	.....	2.0	0.4	.....
Classification	4.0	5.6	3.3	1.4	8.2	0.8	10.7	4.2	2.8	4.2	0.9	3.5	4.0	5.0	5.4
External morphology	34.3	10.7	20.0	26.3	20.7	18.7	12.2	11.0	22.4	15.8	7.6	8.0	28.7	14.2	12.8
Internal morphology	23.3	3.7	11.0	5.6	4.2	9.4	10.5	15.0	20.8	4.6	3.5	5.4	8.2	5.4	7.6
Paleozoölogy	.....	2.4	4.6	1.7	0.2	0.4	0.2	0.9	1.0	2.4	.....	.....	.....	0.4	0.6
Archaeology and ethnology	.....	3.4	.....	.....	3.5	.....	0.5	.....	.....	3.0	.....	.....	1.0	.....	.....
Evolution	1.5	12.4	4.5	1.7	7.4	.....	3.4	5.7	1.8	.....	.....	.....	2.0	0.2	2.7
Miscellaneous zoölogy	0.4	2.7	.....	3.1	2.1	0.8	8.3	4.2	.....	0.7	.....	1.7	3.0	.....	.....
Human physiology	.....	18.2	.....	.....	.....	27.7	.....	.....	2.6	18.7	24.9	20.8	.....	.....	.....
Plants	.....	.....	.....	.....	.....	34.5	2.5	.....	.....	.....	36.2	41.3	.....	.....	.....
Physical geography and mineralogy	.....	.....	.....	.....	.....	.....	2.8	.....	.....	.....	.....	.....	.....	.....	.....
	96.7	94.0	99.9	99.9	98.4	98.3	100.2	100.5	100.8	100.0	99.4	99.7	100.5	99.9	100.1

each book in the tabulation has been analyzed by at least two persons, whose results agree reasonably well. The texts vary greatly in ease of analysis. Often the estimate of space devoted to particular topics must be made in terms of lines. The following paragraph from Holder's *Zoölogy* will serve as an illustration:

> HERRING-PIKES (*Elopidae*). This family includes the tarpon (*Megalops thrissoides*) and the big-eyed herring. The former attains a length of over eight feet, and is the most beautiful of all fishes, ranging from Cape Cod to Florida. An allied form, the *Studis* or *Piraruca*, of South America, attains a length of fifteen feet, and a weight of four hundred pounds. They have skeletons of massive build. The young, according to Schomburgh, enter the mother's mouth in time of danger. Allied are the herrings (*Clupeidae*), shad, menhaden, and the gizzard-shad. They are nearly all important food-fishes. Menhaden oil and guano are valued. The scales of the tarpon are used in ornamental work.

It is evident that this one paragraph treats of classification, geographical distribution, life-history, morphology, and economic zoölogy. Such material makes analysis difficult. A text like Needham's *Elementary Lessons in Zoölogy*, on the other hand, is analyzed with ease, for the topic of each paragraph is indicated in bold-faced type.

The analysis of a text in zoölogy is evidently dependent on personal judgment. Just what sort of material shall be included under each heading might be decided differently by different individuals if they were not working simultaneously and under the same set of directions. Thus it will be noted in the analyses of Hegner's text that 26.3 per cent of the text deals with the habits of animals; and that 14.2 per cent of the text deals with external morphology. In the material dealing with habits, there occur a great many illustrations which are simply pictures of the animals under discussion. While they occur in the midst of text that is plainly to be classed under habits, they themselves illustrate external morphology, as a rule, and have been so counted. Illustrations that really deal with habits, as a picture of a beaver dam and house, are included in the material dealing with habits. This illustration is given simply to show that it is often difficult to decide just how subject-matter should be classed. It is evident that even with the best of instructions, and with attempted uniformity in judgment, the analyses are subject to more or less variation.

To check this, the same text was analyzed by several students, and the results were compared. It was found that the personal variations were not sufficient to change the results materially. Two analyses of two texts are given, as typical. They were made by different persons.

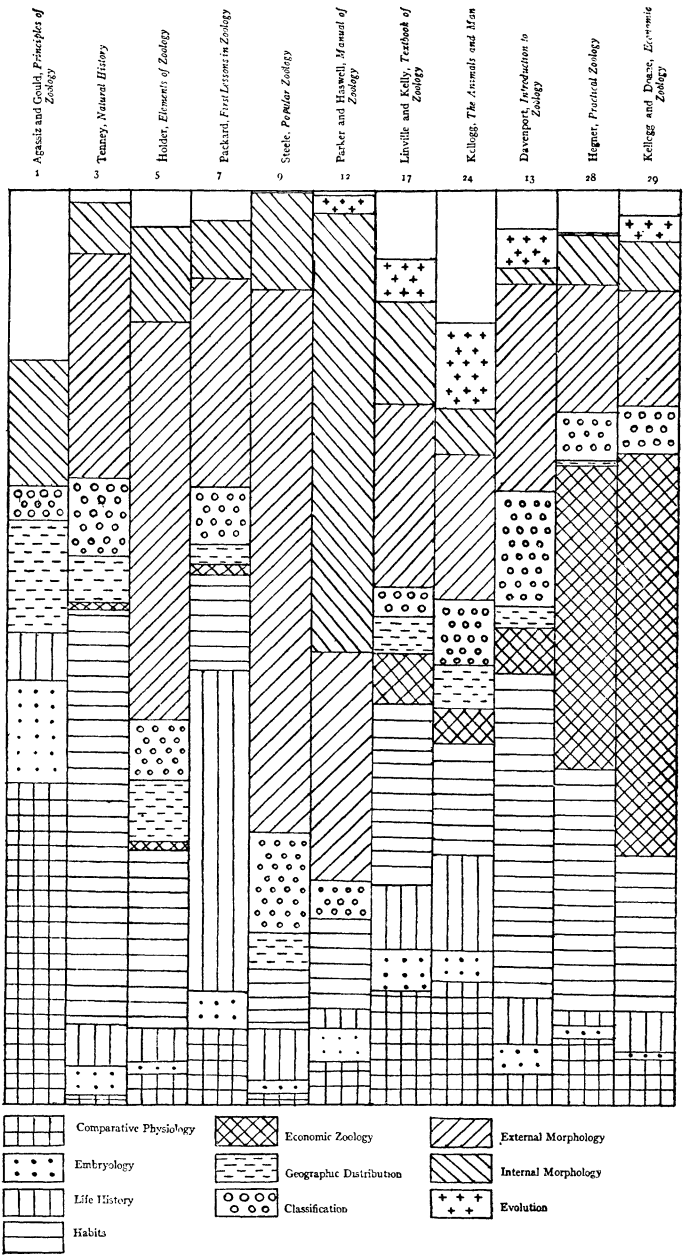
	Orton's *Comparative Zoölogy*		Davidson's *Practical Zoölogy*	
	Per cent	Per cent	Per cent	Per cent
Collecting and preserving	.....	.....	2.3	1.1
History of zoölogy	0.4	1.6	.....	.....
Biography	0.7	0.7	0.8	.....
Comparative physiology	0.5	0.5	4.5	2.6
Embryology	4.3	6.0	2.8	2.0
Life-history	2.4	3.2	12.5	14.5
Habits	3.4	3.4	16.3	14.5
Economic zoölogy	.....	.....	20.9	20.0
Histology	4.0	4.3	.....	.....
Geographical distribution	3.0	3.0	.....	.....
Classification	4.4	2.7	1.4	1.4
External morphology	37.0	36.0	26.3	23.3
Internal morphology	40.4	37.7	5.6	7.6
Paleozoölogy	.....	0.5	1.7	.....
Evolution	.....	.....	.....	.....
Miscellaneous zoölogy	.....	.....	.....	.....
Physical geography and mineralogy	.....	0.8	3.1	.....
	100.5	100.4	99.2	90.8

The analyses of texts given in the tabulation make very evident the successive stages in the history of zoölogy instruction in this country. To make this more apparent, however, and to bring out more forcibly the contrast in types of textbooks, the analyses of typical texts are compared in a graphical way in the accompanying figure. The periods of zoölogical instruction have been already noted in preceding articles, as in Miss Marion Brown's "History of Zoölogy in High Schools," *School Science*, II, 201, 256.

Miss Brown divides the history of zoölogy instruction into four periods:

First, a Natural History period, from 1825 to 1875. It is marked by such books as Hooker's *Natural History* and Tenney's *Natural History*.

Second, a Comparative Anatomy period, from 1875 to 1886. In this period such texts as Holder's *Elementary Zoölogy*, Nicholson's *Textbook of Zoölogy*, and Packard's *First Lessons* in *Zoölogy* are included.


Agassiz and Gould, Principles of Zoology
1
Tenney, Natural History
3
Holder, Elements of Zoology
5
Packard, First Lessons in Zoology
7
Steele, Popular Zoology
9
Parker and Haswell, Manual of Zoology
12
Linville and Kelly, Textbook of Zoology
17
Kellogg, The Animals and Man
24
Davenport, Introduction to Zoology
13
Hegner, Practical Zoology
28
Kellogg and Dearn, Economic Zoology
29
Comparative Physiology
Embryology
Life History
Habits
Economic Zoology
Geographic Distribution
Classification
External Morphology
Internal Morphology
Evolution

Third, the Evolution period, from 1886 to 1890. It is marked not only by the treatment of animals in the evolution series, but also by the extensive introduction of the laboratory method.

Fourth, a combination of the natural history and comparative anatomy methods of treatment, from 1900 to the present time.

A study of the accompanying tabulation shows the need of a revision of such periods in the history of American zoölogy instruction. In the main, these results agree with Miss Brown's conclusions, but Agassiz' *Principles of Zoölogy* is a book that certainly should not be omitted in any discussion of American zoölogy instruction. It is distinctive enough to mark the first period. There were other books of somewhat the same type. The approach is distinctly from the physiological point of view. As will be seen in the analysis of the book, a great deal of the subject-matter is comparative physiology.

The periods suggested are as follows:

First, the Physiology period.

Second, the Natural History period. Habits and the related morphology make up the bulk of the texts.

Third, the Comparative Anatomy period (possibly better designated the Classification period). External and internal morphology are the dominant topics. The treatment is discursive. The animals treated are taken in the order of some accepted system of classification.

Fourth, the Evolution period. The animals studied are a selected series to illustrate the successive advances in complexity which have supposedly come about through the process of evolution. The period is marked by the laboratory manual. Zoölogy has come to be a study *of* animals, rather than *about* animals. Evolution as a definite topic receives little space.

Fifth, the Ecological period. There is a conscious return to a natural history point of view. But the treatment is more dynamic than in the early Natural History period. There is a large element of comparative physiology present. Habits and life-histories are interpreted in terms of physiological reactions. Linville and Kelly's *Textbook of Zoölogy*, Kellogg's *The Animals and Man*, and Davenport's *Introduction to Zoölogy* are typical texts. The latter does not have a conspicuous physiological basis, but the treatment is distinctly ecological. Throughout it is adapted to field work. Linville and Kelly's *Textbook of Zoölogy* is probably the most widely used text at present.[1] It is a satisfaction to see so widespread a reaction from the old morphological treatment of zoölogy in secondary schools.

[1] See Elliot R. Downing, "Some Data Regarding the Teaching of Zoölogy in Secondary Schools," *School Science and Mathematics*, XV (1915), 41.

It is not at all certain that the last two periods suggested ought not to be classed together as a modern period, with a rather chaotic complex of characteristics. In venturing to subdivide and characterize the periods, I am perhaps more prophet than historian. It looks, however, as if the same criterion were coming into use in judging the appropriate material for a high-school text in zoölogy that is so current elsewhere in education, namely, that only such material will be included as is likely to function in ordinary life.

It is evident from the introductions of old and new texts, or from early chapters on the teaching of zoölogy, that many of the authors were conscious of the particular phase of zoölogy instruction that was dominant at the time of the issue of the book. Agassiz says:

> This general view of zoölogy it is the purpose of this work to afford. . . . . To accomplish this, we are at once involved in the question, What is it that gives an animal precedence in rank? . . . . Each species has its definite sphere of action, whether more or less extended—its own peculiar office in the economy of nature; and a complete adaptation to fulfil all the purposes of its creation, beyond the possibility of improvement. In this sense, every animal is perfect. But there is a wide difference among them, in respect to their organization. In some it is very simple, and very limited in its operation; in others, extremely complicated, and capable of exercising a great variety of functions. . . . .
>
> In this *physiological point of view*, an animal may be said to be more perfect in proportion as its relations with the external world are more varied; in other words, the more numerous its functions are. . . . . The study of the functions or uses of organs, therefore, requires an examination of their structure; they must never be disjoined, and must precede the systematic distribution of animals into classes, families, genera, and species.

Agassiz endeavors to distinguish, in addition, the course of development of animals and the regions they inhabit. He closes his introductory chapter as follows:

> He who beholds in Nature nothing besides organs and their functions may persuade himself that the animal is merely a combination of chemical and mechanical actions and reactions, and thus becomes a materialist.
>
> On the contrary, he who considers only the manifestations of intelligence and of creative will, without taking into account the means by which they are executed, and the physical laws by virtue of which all beings preserve their characteristics, will be very likely to confound the Creator with the creature.
>
> It is only as it contemplates, at the same time, matter and mind, that Natural History rises to its true character and dignity, and leads to its worthiest

end, by indicating to us, in Creation, the execution of a plan fully matured in the beginning, and undeviatingly pursued; the work of a God infinitely wise, regulating Nature according to immutable laws, which He has himself imposed on her.

Hooker's Preface reads quite like a modern article on the value of natural history in the schools. He states some considerations that show that zoölogy ought to have a prominent place in academies and common schools. First, zoölogy has a practical bearing; second, it shows how animals are distributed over the earth and their relation to climate and other environmental factors; third, it is excellent drill for the mental powers; fourth, it is a good basis for drill in language; fifth, it opens "never-ending resources for agreeable mental improvement"; sixth, there is a valuable "moral effect of the early study of natural science." In most of these early natural-history texts, there is a reverent attitude, the author expressing the conviction that the zoölogist is discovering the thoughts of the Creator.

Holder, in his Preface, says that "the real business of the learner is to gain a true and vivid conception of the characteristics of what may be termed the natural orders of animals," which seems to express tersely the dominant aim in the third period.

The transition to the evolution point of view is well shown in the following quotation from Parker and Haswell's *Manual of Zoölogy*. This was probably not widely used as a high-school text, but no book has been more influential in college instruction and in establishing the type of work done in the secondary schools.

But it was assumed that creation had taken place according to a certain scheme in the Divine Mind, and that the various species had their place in this scheme like the bits of glass in a mosaic. The problem of classification was thus to discover the place of each species in the pattern of unknown design.

The point of view underwent a complete change when, after the publication of Darwin's *Origin of Species* in 1859, the Doctrine of Descent or of Organic Evolution came to be generally accepted by biologists. A species is now looked upon, not as an independent creation, but as having been derived by a natural process of descent from some pre-existing species, just as the various breeds of Domestic Fowl are descended from the little jungle-fowl of India. On this view the resemblance between species referred to above are actually matters of relationship, and species are truly allied to one another in varying degrees,

since they are descended from a common ancestor. Thus a natural classification becomes a genealogical tree, and the problem of classification is the tracing of its branches.

Davenport, in his Preface, says that the general plan of his textbook "is at the same time both old and new; old, because it attempts to restore the old time instruction in natural history; new, because natural history is not today what it was a generation ago." In the first chapter of Kellogg and Doane's *Economic Zoölogy* the aim of the book is expressed as follows: "This book, therefore, ... is intended to guide students who wish to learn about animals from the special point of view of their interrelations with man, that is, their possible use and hurtfulness, and even danger, to yourself. . . . ."

The study of morphology from the evolutionary point of view has dominated high-school instruction altogether too long. It never was appropriate subject-matter for the secondary schools. It made up the bulk of the college course at one time, perhaps still does. The college-trained man, undertaking to teach zoölogy in the high school, naturally attempted to teach, in a diluted form, what had been taught to him, without much thought as to whether it was appropriate subject-matter for the pupils in his charge. There are signs that the high school is more or less dissatisfied with the sort of zoölogy instruction that has been given. Possibly the customary content of the course may explain the lessening interest in the subject in certain quarters.

W. J. Bray, in a study of first-class high schools of Missouri, published in the *Normal School Index*, February 5, 1915, showed that while the enrolment in 1905 in the first-class high schools in Missouri was 9.7 per cent in zoölogy, in 1915 it had dropped to 1.2 per cent. Fred D. Barbour, in an article on the "Present Status and General Meaning of General Science,"[1] shows that the enrolment in all of the old-line sciences has declined. The statistics that he quotes from the Reports of the Commissioner of Education do not include those for zoölogy for a sufficiently long period to indicate that this is the case with this particular subject, but it may be no exception to the general rule.

[1] *School Science and Mathematics*, XV (1915), 218–24.

I find that in 1909–10, 237 students were enrolled in zoölogy in North Carolina high schools (Reports of State Inspector). The next year only 29 were so enrolled; the following year 18, and one year later the subject had disappeared from the curriculum. Biology had come in, however, and in 1913-14 had an enrolment of 158. This is a relatively insignificant part of the total enrolment in science, which was 10,433 for 1913–14; in 1908–9 it was 5,955. High-school attendance was 15,688 in 1913–14 and 10,689 in 1908–9.

That the decline in interest in zoölogy is not universal, however, is evident from other available statistics. In Minnesota, the report of the high-school examiner shows that in the period from 1894 to 1914, while the total high-school enrolment has increased about six fold, the enrolment in zoölogy has increased more than seven fold. Available statistics are none too numerous. In going over the reports of the superintendents of public instruction in all of the states, I am unable to find much additional evidence, either pro or con. In Connecticut, however, in the last three years, 1910–13, the enrolment in zoölogy has increased more rapidly than the high-school enrolment. The enrolment in Ohio has increased, but from the figures given, I am not certain that the increase has been more rapid than that of the high-school enrolment. The enrolment in zoölogy in New Jersey in 1905 was 1,171; in 1913, 1,371. During this interval, the total enrolment in science has declined about 6 per cent.